ALPHA & OMEGA SEMICONDUCTOR, LTD

AOD407
P-Channel Enhancement Mode Field Effect Transistor

General Description

The AOD407 uses advanced trench technology to provide excellent $R_{DS(ON)}$, low gate charge and low gate resistance. With the excellent thermal resistance of the DPAK package, this device is well suited for high current load applications.

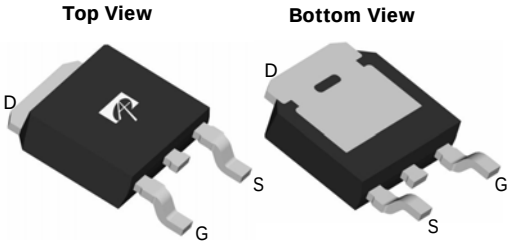
-RoHS Compliant
-Halogen Free*

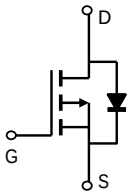
Features

V_{DS} (V) = -60V
I_D = -12A (V_{GS} = -10V)
$R_{DS(ON)}$ < 115mΩ (V_{GS} = -10V)
$R_{DS(ON)}$ < 150mΩ (V_{GS} = -4.5V)

100% UIS tested
100% RG tested

TO252
DPAK





Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		Symbol	Maximum	Units
Drain-Source Voltage		V_{DS}	-60	V
Gate-Source Voltage		V_{GS}	±20	V
Continuous Drain Current [G]	T_C=25°C	I_D	-12	A
	T_C=100°C		-10	
Pulsed Drain Current [C]		I_{DM}	-30	
Avalanche Current [C]		I_{AR}	-12	A
Repetitive avalanche energy L=0.1mH [C]		E_{AR}	23	mJ
Power Dissipation [B]	T_C=25°C	P_D	50	W
	T_C=100°C		25	
Power Dissipation [A]	T_A=25°C	P_{DSM}	2.5	W
	T_A=70°C		1.6	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 175	°C

Thermal Characteristics

Parameter		Symbol	Typ	Max	Units
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{\theta JA}$	16.7	25	°C/W
Maximum Junction-to-Ambient [A]	Steady-State		40	50	°C/W
Maximum Junction-to-Case [B]	Steady-State	$R_{\theta JC}$	2.5	3	°C/W

Electrical Characteristics (T_J=25°C unless otherwise noted)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
STATIC PARAMETERS							
BV_{DSS}	Drain-Source Breakdown Voltage	I_D=-250µA, V_{GS}=0V		-60			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS}=-48V, V_{GS}=0V			-0.003	-1	µA
			T_J=55°C			-5	
I_{GSS}	Gate-Body leakage current	V_{DS}=0V, V_{GS}=±20V				±100	nA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS}=V_{GS} I_D=-250µA		-1.5	-2.1	-3	V
$I_{D(ON)}$	On state drain current	V_{GS}=-10V, V_{DS}=-5V		-30			A
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS}=-10V, I_D=-12A			91	115	mΩ
			T_J=125°C		150		
		V_{GS}=-4.5V, I_D=-8A			114	150	mΩ
g_{FS}	Forward Transconductance	V_{DS}=-5V, I_D=-12A			12.8		S
V_{SD}	Diode Forward Voltage	I_S=-1A,V_{GS}=0V			-0.76	-1	V
I_S	Maximum Body-Diode Continuous Current					-12	A
DYNAMIC PARAMETERS							
C_{iss}	Input Capacitance	V_{GS}=0V, V_{DS}=-30V, f=1MHz			987	1185	pF
C_{oss}	Output Capacitance				114		pF
C_{rss}	Reverse Transfer Capacitance				46		pF
R_g	Gate resistance	V_{GS}=0V, V_{DS}=0V, f=1MHz			7	10	Ω
SWITCHING PARAMETERS							
Q_g(10V)	Total Gate Charge (10V)	V_{GS}=-10V, V_{DS}=-30V, I_D=-12A			15.8	20	nC
Q_g(4.5V)	Total Gate Charge (4.5V)				7.4	9	nC
Q_{gs}	Gate Source Charge				3		nC
Q_{gd}	Gate Drain Charge				3.5		nC
$t_{D(on)}$	Turn-On DelayTime	V_{GS}=-10V, V_{DS}=-30V, R_L=2.5Ω, R_{GEN}=3Ω			9		ns
t_r	Turn-On Rise Time				10		ns
$t_{D(off)}$	Turn-Off DelayTime				25		ns
t_f	Turn-Off Fall Time				11		ns
t_{rr}	Body Diode Reverse Recovery Time	I_F=-12A, dI/dt=100A/µs			27.5	35	ns
Q_{rr}	Body Diode Reverse Recovery Charge	I_F=-12A, dI/dt=100A/µs			30		nC

A: The value of $R_{\theta JA}$ is measured with the device mounted on 1in 2 FR-4 board with 2oz. Copper, in a still air environment with T_A=25°C. The Power dissipation P_{DSM} is based on $R_{\theta JA}$ and the maximum allowed junction temperature of 150°C. The value in any given application depends on the user's specific board design, and the maximum temperature of 175°C may be used if the PCB allows it.

B. The power dissipation P_D is based on $T_{J(MAX)}$=175°C, using junction-to-case thermal resistance, and is more useful in setting the upper dissipation limit for cases where additional heatsinking is used.

C: Repetitive rating, pulse width limited by junction temperature $T_{J(MAX)}$=175°C.

D. The $R_{\theta JA}$ is the sum of the thermal impedence from junction to case $R_{\theta JC}$ and case to ambient.

E. The static characteristics in Figures 1 to 6 are obtained using <300 µs pulses, duty cycle 0.5% max.

F. These curves are based on the junction-to-case thermal impedence which is measured with the device mounted to a large heatsink, assuming a maximum junction temperature of $T_{J(MAX)}$=175°C.

G. The maximum current rating is limited by bond-wires.

H. These tests are performed with the device mounted on 1 in 2 FR-4 board with 2oz. Copper, in a still air environment with T_A=25°C. The SOA curve provides a single pulse rating.

*This device is guaranteed green after data code 8X11 (Sep 1 ST 2008).

Rev 7 : May 2010

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

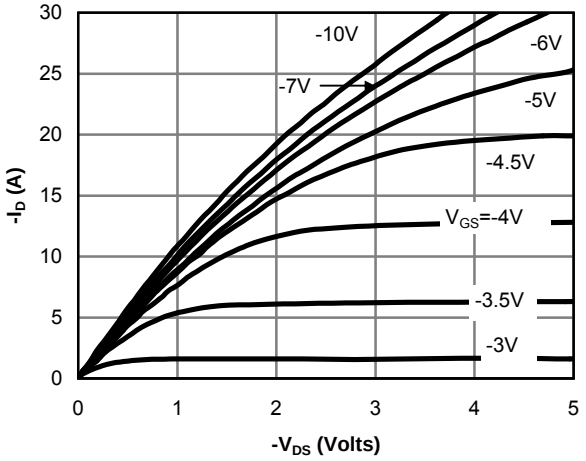


Fig 1: On-Region Characteristics

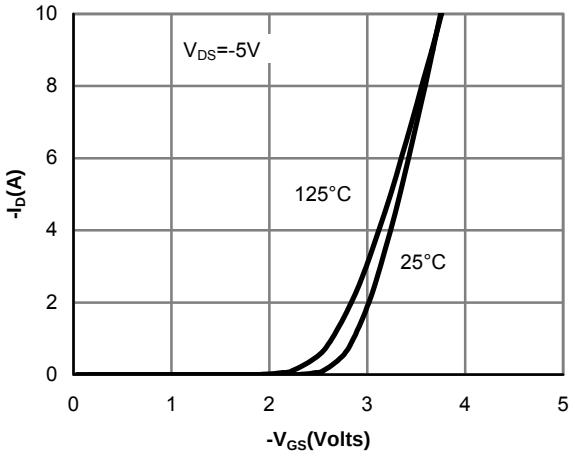


Figure 2: Transfer Characteristics

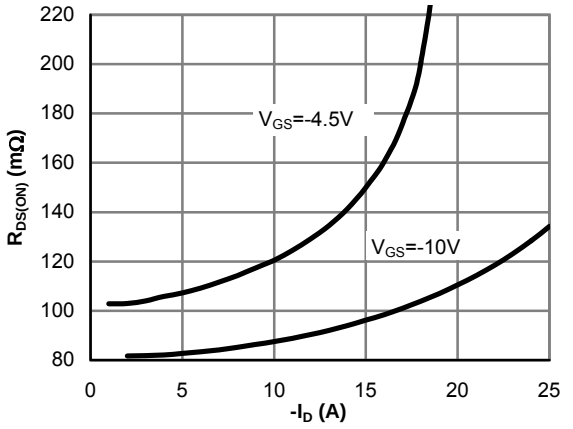


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

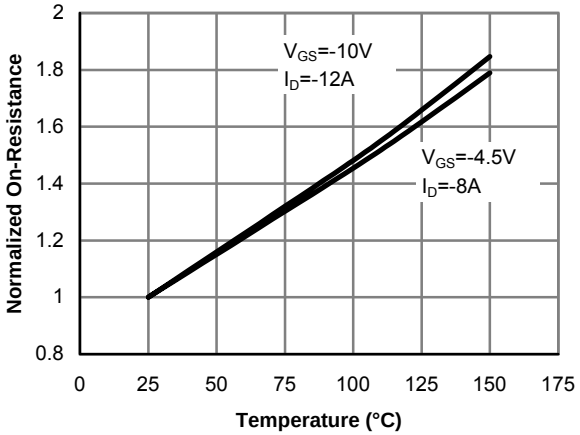


Figure 4: On-Resistance vs. Junction Temperature

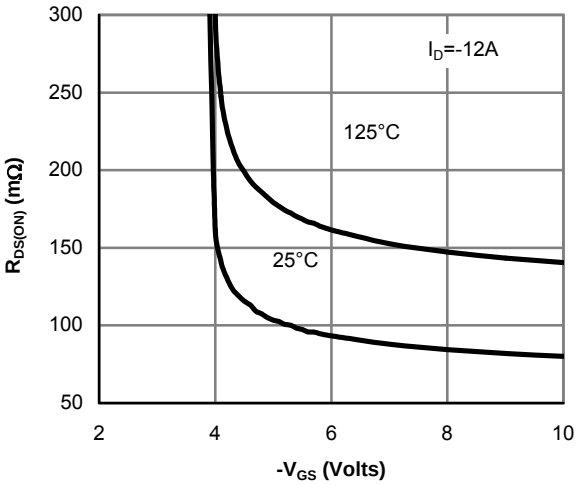


Figure 5: On-Resistance vs. Gate-Source Voltage

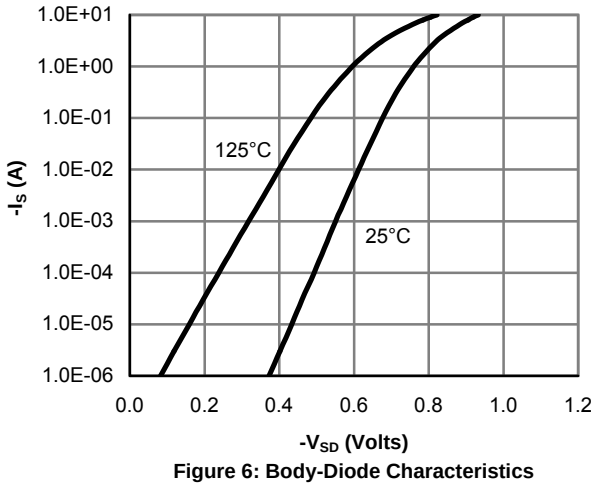


Figure 6: Body-Diode Characteristics

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

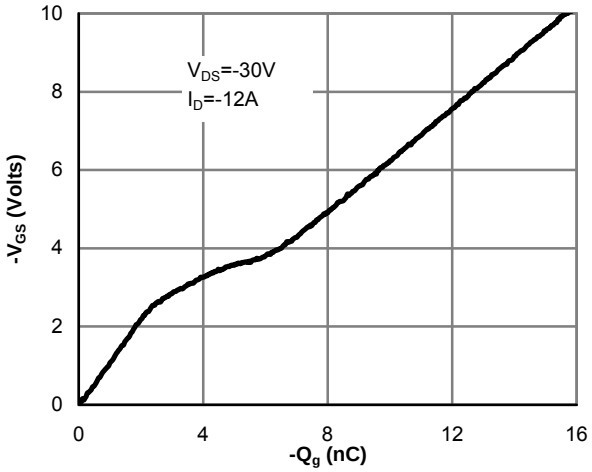


Figure 7: Gate-Charge Characteristics

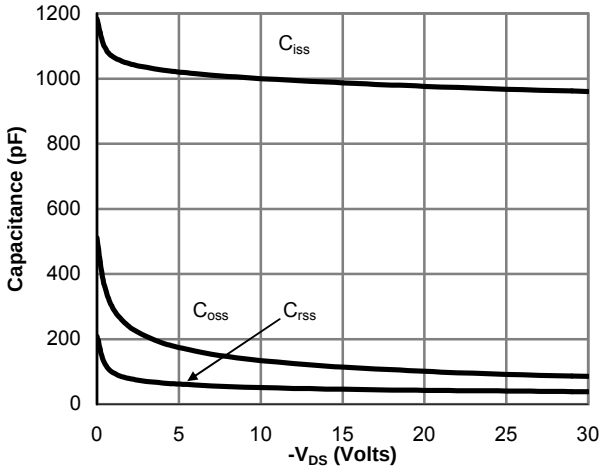


Figure 8: Capacitance Characteristics

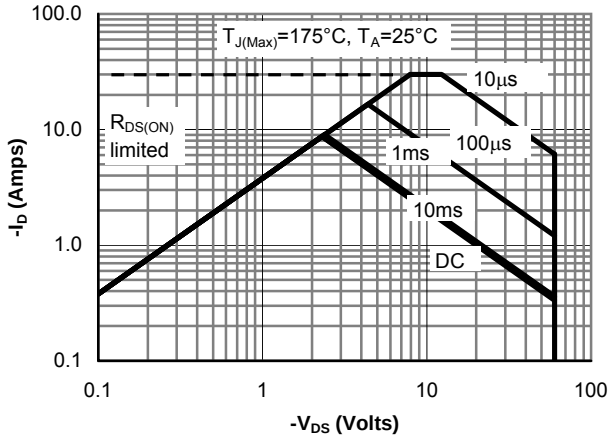


Figure 9: Maximum Forward Biased Safe Operating Area (Note F)

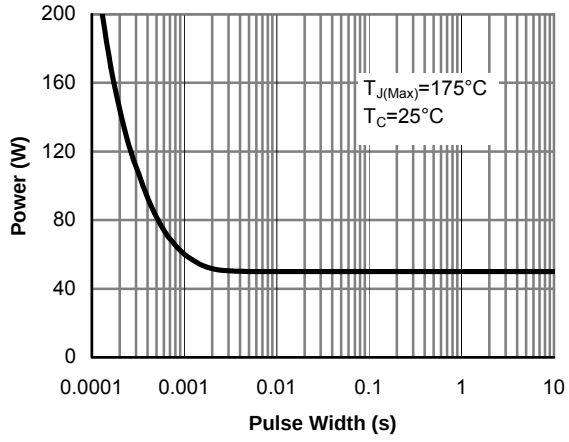


Figure 10: Single Pulse Power Rating Junction-to-Case (Note F)

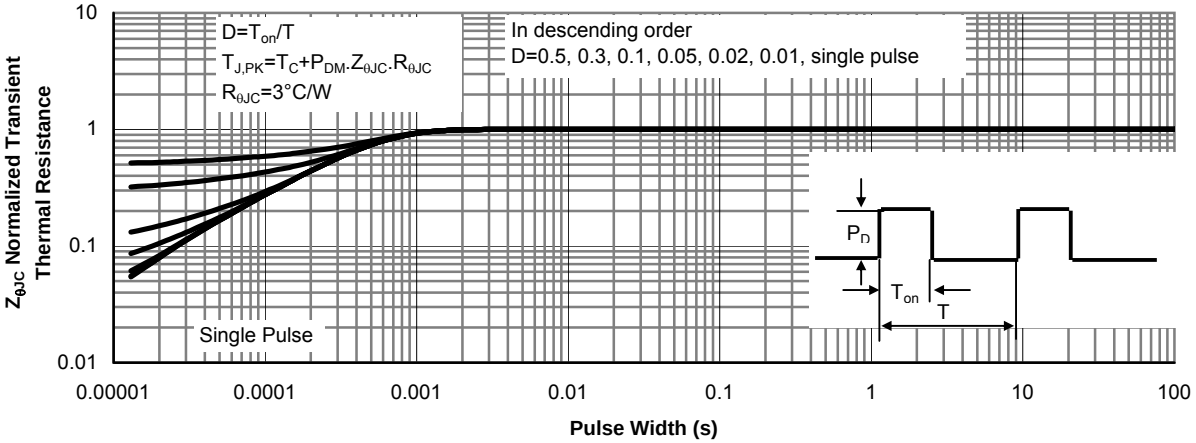


Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

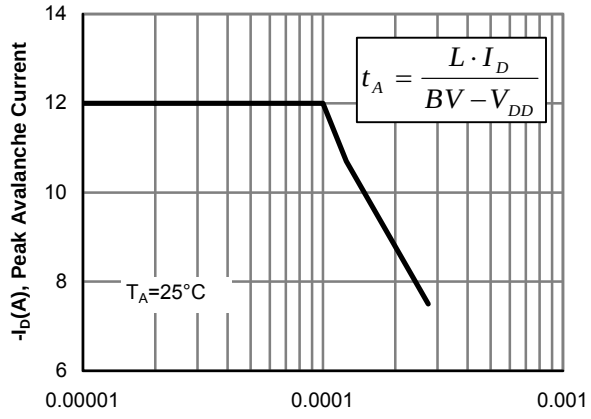


Figure 12: Single Pulse Avalanche capability

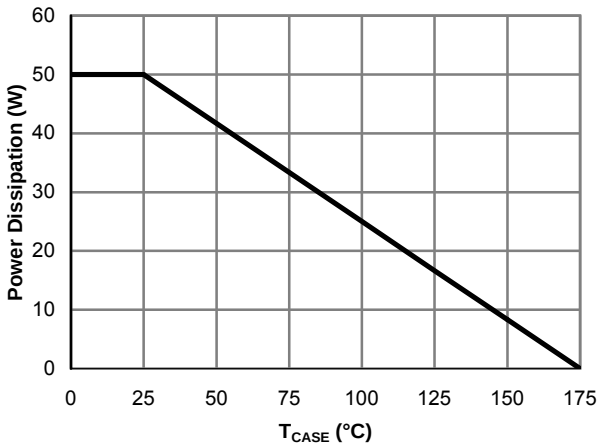


Figure 13: Power De-rating (Note B)

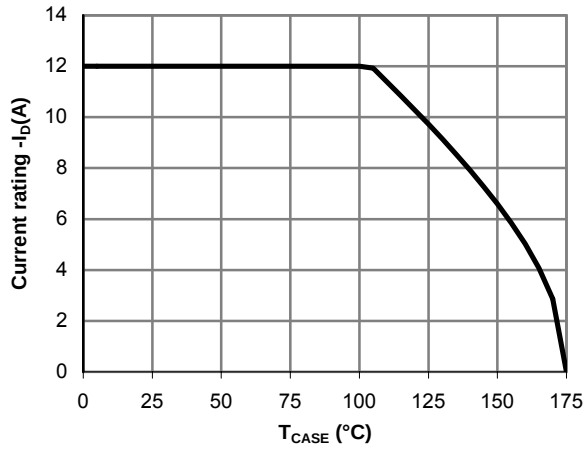


Figure 14: Current De-rating (Note B)

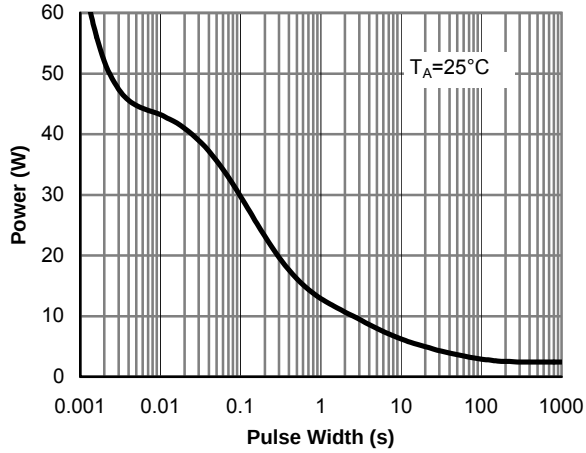


Figure 15: Single Pulse Power Rating Junction-to-Ambient (Note H)

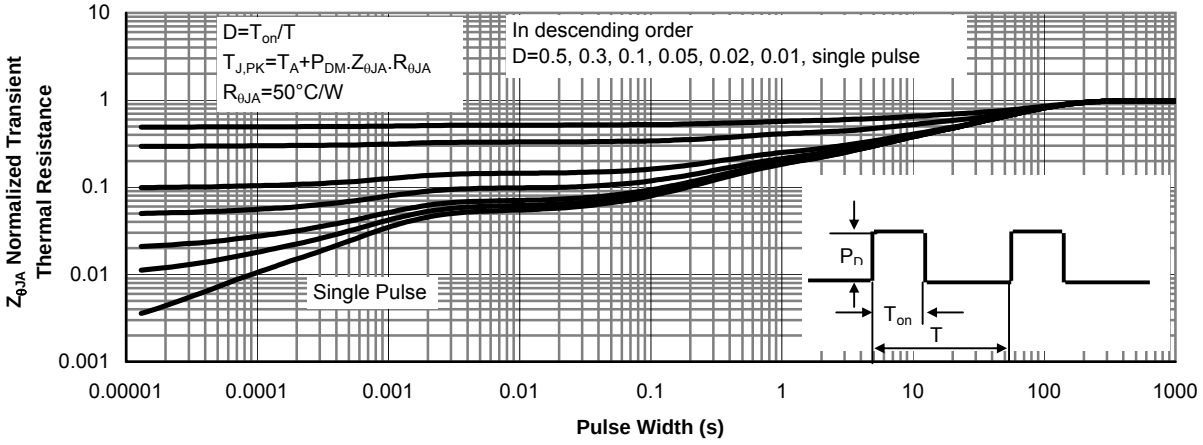
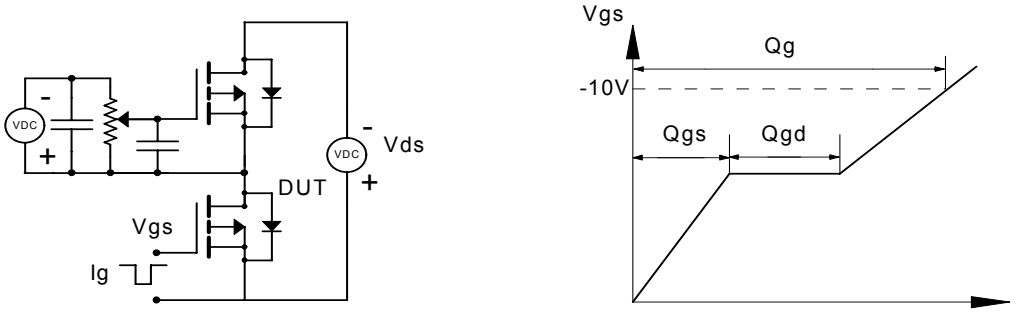
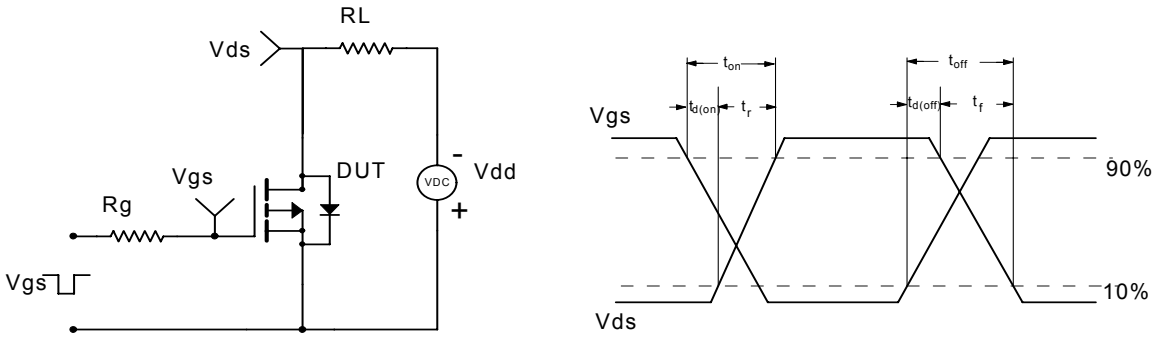


Figure 16: Normalized Maximum Transient Thermal Impedance (Note H)

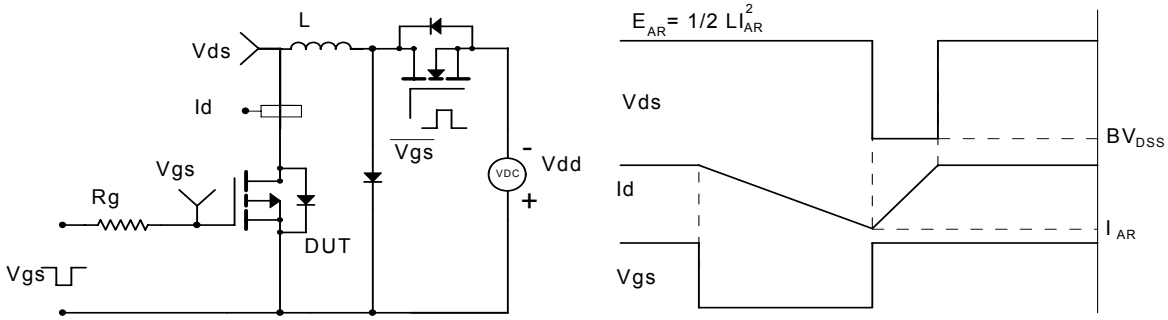
Gate Charge Test Circuit & Waveform



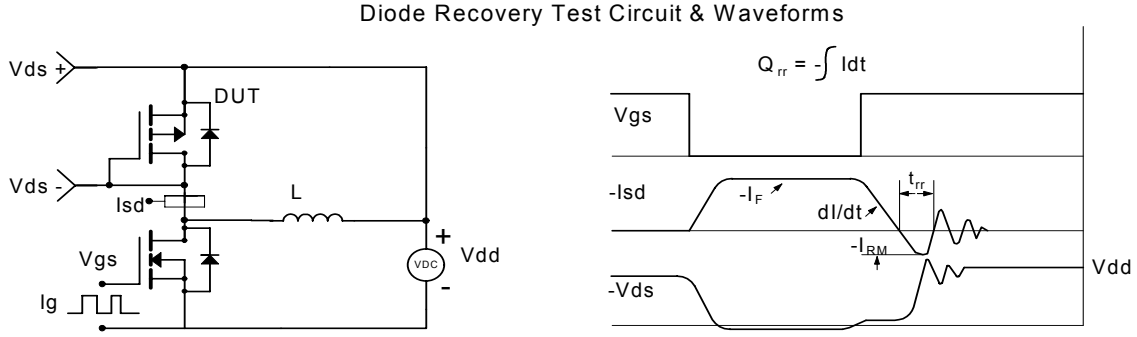
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



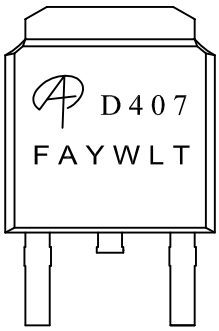
Diode Recovery Test Circuit & Waveforms



ALPHA & OMEGA SEMICONDUCTOR

Document No.	PD-00718
Version	C
Title	AOD407 Marking Description

DPAK PACKAGE MARKING DESCRIPTION



Green product

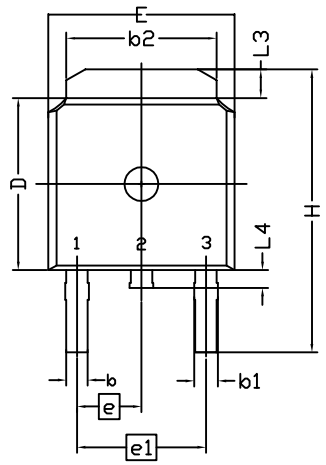
NOTE:
LOGO - AOS Logo
D407 - Part number code
F - Fab code
A - Assembly location code
Y - Year code
W - Week code
L&T - Assembly lot code

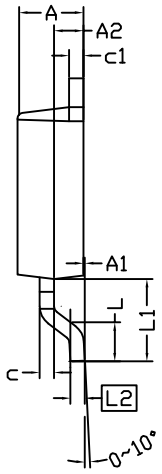
PART NO.	DESCRIPTION	CODE
AOD407	Green product	D407
AOD407L	Green product	D407

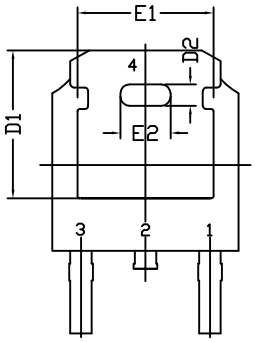
ALPHA & OMEGA
SEMICONDUCTOR, LTD.

Document No.	PO−00009
Version	S

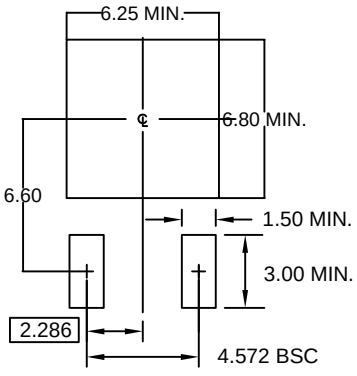
TO252(DPAK) PACKAGE OUTLINE







RECOMMENDED LAND PATTERN



UNIT: mm

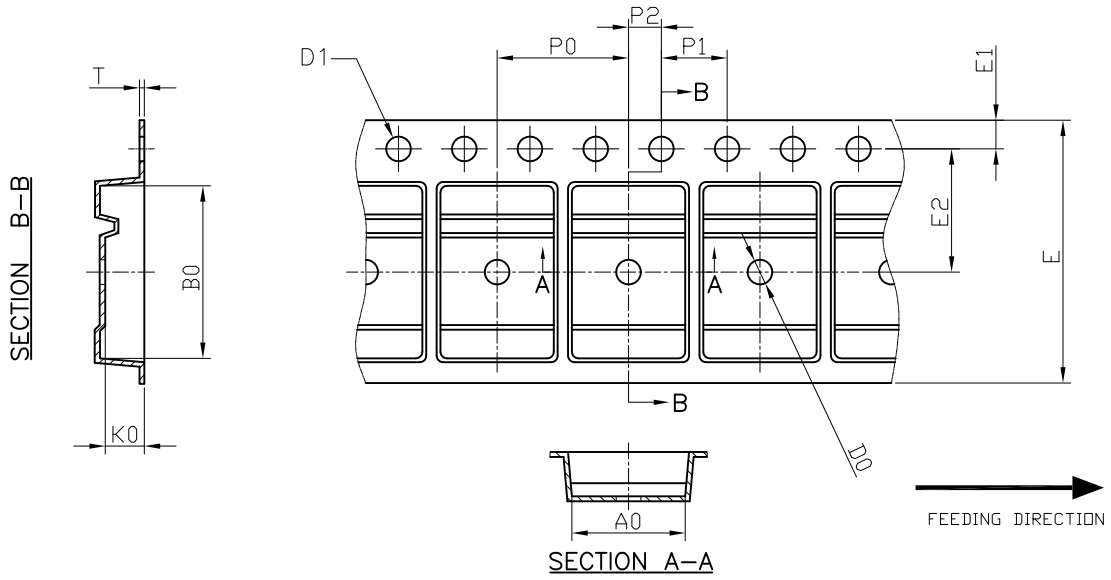
SYMBOL	DIMENSION IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	2.184	2.286	2.388	0.086	0.090	0.094
A1	0.000	-----	0.127	0.000	-----	0.005
A2	0.889	1.041	1.143	0.035	0.041	0.045
b	0.635	0.762	0.889	0.025	0.030	0.035
b1	0.762	0.840	1.143	0.030	0.033	0.045
b2	4.953	5.340	5.461	0.195	0.210	0.215
c	0.450	0.508	0.610	0.018	0.020	0.024
c1	0.450	0.508	0.610	0.018	0.020	0.024
D	5.969	6.096	6.223	0.235	0.240	0.245
D1	5.210	5.249	5.380	0.205	0.207	0.212
D2	0.662	0.762	0.862	0.026	0.030	0.034
E	6.350	6.604	6.731	0.250	0.260	0.265
E1	4.318	4.826	4.901	0.170	0.190	0.193
E2	1.678	1.778	1.878	0.066	0.070	0.074
e	2.286 BSC			0.090 BSC		
e1	4.572 BSC			0.180 BSC		
H	9.398	10.033	10.414	0.370	0.395	0.410
L	1.270	1.520	2.032	0.050	0.060	0.080
L1	2.921 REF.			0.115REF.		
L2	0.408	0.508	0.608	0.016	0.020	0.024
L3	0.889	1.016	1.270	0.035	0.040	0.050
L4	0.635	-----	1.016	0.025	-----	0.040

NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS. MOLD FLASH SHOULD BE LESS THAN 6 MILS.
2. DIMENSION L IS MEASURED IN GAUGE PLANE
3. TOLERANCE 0.10 mm UNLESS OTHERWISE SPECIFIED
4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
5. REFER TO JEDEC TO-252 (AA)

ALPHA & OMEGA SEMICONDUCTOR

DPAK Tape and Reel Data

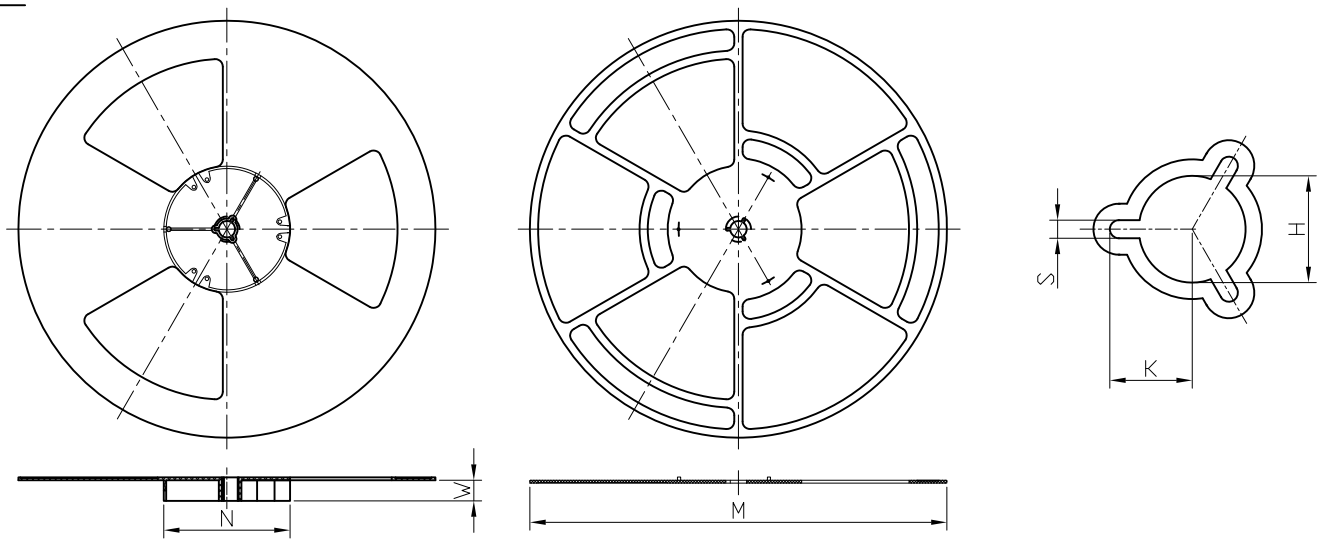
DPAK Carrier Tape



UNIT: MM

PACKAGE	A0	B0	K0	D0	D1	E	E1	E2	P0	P1	P2	T
DPAK (16 mm)	6.90 ±0.10	10.50 ±0.10	2.50 ±0.10	1.50 +0.1 −0	1.50 +0.1 −0	16.00 ±0.30	1.75 ±0.10	7.50 ±0.10	8.00 ±0.10	4.00 ±0.10	2.00 ±0.10	0.30 ±0.05

DPAK Reel



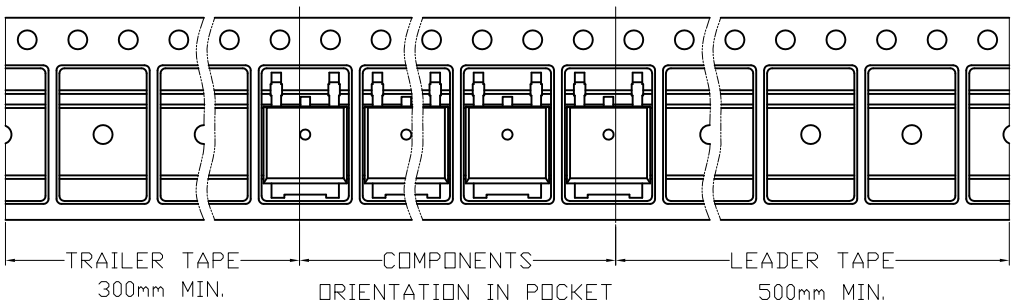
UNIT: MM

TAPE SIZE	REEL SIZE	M	N	W	H	K	S
16 mm	ø330	ø330.00 +0.25 −4.00	ø100.00 ±0.2	16.4 +2.0 −0.0	ø13.00 +0.50 −0.20	10.5 ±0.25	2.2 ±0.25

DPAK Tape

Leader / Trailer & Orientation

Unit Per Reel: 2500pcs



AOS Semiconductor
Product Reliability Report

AOD407 rev C

Plastic Encapsulated Device

ALPHA & OMEGA Semiconductor, Inc

495 Mercury Drive
Sunnyvale, CA 94085
U.S.

Tel: (408) 830-9742 **www.aosmd.com**

ALPHA & OMEGA SEMICONDUCTOR

This AOS product reliability report summarizes the qualification result for AOD407. Accelerated environmental tests are performed on a specific sample size, and then followed by electrical test at end point. Review of final electrical test result confirms that AOD407 passes AOS quality and reliability requirements. The released product will be categorized by the process family and be monitored on a quarterly basis for continuously improving the product quality.

Table of Contents:

I. Product Description:

The AOD407 uses advanced trench technology to provide excellent $R_{DS(ON)}$, low gate charge and low gate resistance. With the excellent thermal resistance of the DPAK package, this device is well suited for high current load applications.

-RoHS Compliant
-Halogen Free

Absolute Maximum Ratings T_A=25°C unless otherwise noted				
Parameter		**Symbol**	**Maximum**	**Units**
Drain-Source Voltage		V_{DS}	-60	V
Gate-Source Voltage		V_{GS}	±20	V
Continuous Drain Current [G]	T_C=25°C	I_D	-12	A
	T_C=100°C		-10	
Pulsed Drain Current [C]		I_{DM}	-30	
Avalanche Current [C]		I_{AR}	-12	A
Repetitive avalanche energy L=0.1mH [C]		E_{AR}	23	mJ
Power Dissipation [B]	T_C=25°C	P_D	50	W
	T_C=100°C		25	
Power Dissipation [A]	T_A=25°C	P_{DSM}	2.5	W
	T_A=70°C		1.6	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 175	°C

Thermal Characteristics					
Parameter		**Symbol**	**Typ**	**Max**	**Units**
Maximum Junction-to-Ambient [A]	t ≤ 10s	$R_{\theta JA}$	16.7	25	°C/W
Maximum Junction-to-Ambient [A]	Steady-State		40	50	°C/W
Maximum Junction-to-Case [B]	Steady-State	$R_{\theta JC}$	2.5	3	°C/W

ALPHA & OMEGA SEMICONDUCTOR

II. Die / Package Information:

	AOD407
Process	Standard sub-micron Low voltage P channel process
Package Type	3 leads TO252
Lead Frame	Bare Cu
Die Attach	Soft solder
Bond wire	G: Au 1.3mils; S: Al 12mils
Mold Material	Epoxy resin with silica filler
Flammability Rating	UL-94 V-0
Backside Metallization	Ti / Ni / Ag
Moisture Level	Up to Level 1 *

Note * based on info provided by assembler and mold compound supplier

III. Result of Reliability Stress for AOD407

Test Item	Test Condition	Time Point	Lot Attribution	Total Sample size	Number of Failures
Solder Reflow Precondition	**168hr 85°c /85%RH +3 cycle reflow@260°c**	**-**	**9 lots**	**1210pcs**	**0**
HTGB	**Temp = 150°c , Vgs=100% of Vgsmax**	**168 / 500 hrs** **1000 hrs**	**6 lots** **(Note A*)**	**492pcs** **77+5 pcs / lot**	**0**
HTRB	**Temp = 150°c , Vds=80% of Vdsmax**	**168 / 500 hrs** **1000 hrs**	**6 lots** **(Note A*)**	**492pcs** **77+5 pcs / lot**	**0**
HAST	**130 +/- 2°c , 85%RH, 33.3 psi, Vgs = 80% of Vgs max**	**100 hrs**	**9 lots** **(Note B**)**	**495pcs** **50+5 pcs / lot**	**0**
Pressure Pot	**121°c , 29.7psi, 100%RH**	**96 hrs**	**5 lots** **(Note B**)**	**275pcs** **50+5 pcs / lot**	**0**
Temperature Cycle	**-65°c to 150°c , air to air,**	**250 / 500 cycles**	**8 lots** **(Note B**)**	**440pcs** **50+5 pcs / lot**	**0**

III. Result of Reliability Stress for AOD407

Continues

DPA	**Internal Vision** **Cross-section** **X-ray**	**NA**	**5** **5** **5**	**5** **5** **5**	**0**
CSAM		**NA**	**5**	**5**	**0**
Bond Integrity	**Room Temp** **150°c bake** **150°c bake**	**0hr** **250hr** **500hr**	**40** **40** **40**	**40 wires** **40 wires** **40 wires**	**0**
Solderability	**245°c**	**5 sec**	**15**	**15 leads**	**0**
Solder dunk	**260°c**	**10secs** **3 cycles**	**1**	**30 units**	**0**

Note A: The HTGB and HTRB reliability data presents total of available AOD407 burn-in data up to the published date.
Note B: The pressure pot, temperature cycle and HAST reliability data for AOD407 comes from the AOS generic package qualification data.

IV. Reliability Evaluation

FIT rate (per billion): 9
MTTF = 12331 years